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Conservation veterinary nursing in Vietnam – Wound management in the Sunda pangolin, *Manis javanica*

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ABSTRACT: Sunda pangolins are classed as critically endangered and are regarded as the world's most trafficked mammal. Those rescued from the illegal wildlife trade and rehabilitated for release require veterinary care and intervention during this process. Wound management and wound healing is a key part of this rehabilitation process and is discussed in this article. The principles of wound healing, dressings and the use of light therapy are covered and case examples from the author's visit to a centre in Vietnam included.

Keywords: Pangolins; wound dressings; wound management

Introduction

Sunda/Malayan pangolin, *Manis javanica*

The Sunda pangolin (Figure 1) is just one of eight distinct species of pangolin worldwide. They are classed as critically endangered on the ICUN Red List (Challender et al., 2014) and ranked as 92nd on the Evolutionary Distinct and Globally Endangered (EDGE) mammal list (EDGE, 2018). Pangolins are still regarded as the most trafficked wild mammals, despite a commercial trade ban since 2000 for wild-caught pangolins in Asia (ZSL, 2018; Xu, Guan, Lau, & Xia, 2016).

A high level of hunting and poaching for meat, skin and scales for the luxury restaurant, fashion and traditional medicine markets has, and still, results in a large-scale illegal trade in Asian pangolins, and this is having a huge impact on their population (Pangolin Conservation Stakeholders Workshop, 2008; Challender et al., 2014).

The non-profit organisation visited is based in Northern Vietnam and is committed to protecting and increasing populations of threatened wildlife in Vietnam, including Sunda pangolins and a variety of small carnivores.

Their work focuses on all aspects of conservation, including the rescue, rehabilitation and release of those animals confiscated from the illegal wildlife trade.

A large proportion of the pangolins rescued present with wounds, abscesses or dermatitis. The aetiology and severity of the pangolin's wounds varies, but a substantial number are sustained because of the illegal wildlife trade. It is often not known where the animals originated from or how long they had been within the illegal wildlife trade, and they are often kept tightly confined in net bags. The focus of this report is on wound management and healing as part of the pangolin's rehabilitation.

Wounds and wound management

Wounds

A wound occurs when the normal integrity of the tissue becomes interrupted (Caldwell, 2014), typically because of a traumatic event.

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Figure 1. Sunda pangolin.

The key to successful wound healing, according to Anderson (2003), is an accurate and thorough assessment and careful wound management planning. Wound management protocols are in place at the centre and are being continuously developed and adapted based upon research, available products and successful outcomes.

The most common area affected was the caudal part of the tail or tail tip and this often resulted in a partial tail amputation. The aetiology for amputation varied, but was commonly a minor tail injury, small abscess or dermatitis resulting in devitalised tissues and therefore subsequent amputation due to non-healing wounds and risk of infection.

Although the specific cause of this development of infection and necrosis despite good wound care is unknown, the hypothesis is, it is a result of reduced circulation and blood supply due to vasoconstriction. A good vascular supply is essential to wound healing, with blood conveying the necessary cells to enable wound healing (Anderson, 2003; Young, 2013). Environmental temperature, reduced or lack of activity as well as acute or chronic stress could all have cardiovascular impacts and cause vasoconstriction in the extremities. This hypothesis was further reinforced by the higher prevalence during the colder winter months. Not only was the environmental temperature lower, but these months also coincided with a higher volume of pangolins in the centre's care. This resulted in solitary animals having to share den space, which could be considered a stressor.

Dermatitis

Many rescued pangolins present with infected, moist, ulcerative dermatitis between their scales. This is thought to be due to poor hygiene from being transported curled up inside tight nets whilst in the wildlife trade (Thai, Clark, & Phuong, 2014), in which they are unable to move so are usually covered in faeces, dirt and urine. An initial bath was sometimes required to remove most of the dirt, either consciously or under anaesthesia. Affected areas are then cleaned daily with dilute chlorhexidine and 1% iodine or silver sulfadiazine cream is applied.

Wound healing

There are three phases to wound healing:

1. Inflammatory phase (immediate).
2. The proliferative (repair) phase (3–7 days post-injury).
3. The remodelling phase (5–7 days onwards) (Anderson, 1996).

The wound healing process is dynamic and occurs immediately with haemorrhage and inflammation present. In the early inflammatory phase, the initial injury triggers coagulation and stimulation of the inflammatory cascade (O'Dwyer & Demetriou, 2016). The inflammation caused by the initial injury is associated with redness and heat (vasodilation), swelling and pain. Macrophages infiltrate in the late inflammatory phase with a role in debridement, disposing of the platelet clot, dead cells, bacteria and organic debris. A heavily contaminated wound will remain in the inflammatory phase and the healing process will therefore be delayed (Anderson, 1996).

The proliferative phase is the actual tissue repair phase. Fibroblasts migrate into the wound from nearby skin and lay down a new extracellular matrix and manufacture and remodel collagen (Anderson, 1996). Granulation tissue is created, which then provides the framework for subsequent repair (Anderson, 2003). Granulation tissue can vary from red fleshy and finely granular to pale pink to white and nodular depending upon the vascular and collagen content (Hosgood, 2006). This variation was evident in the pangolin tail wounds with vascular supply likely to be the impacting factor as well as the inactive tissue in the chronic cases.

The remodelling phase is the final phase of restoration of normal tissue structure and aims to recover some elasticity and protective function of the skin. With wound closure not possible in most cases due to it being contaminated (for example, an abscess) or a large skin deficit post-amputation, most wound healing was by second intention. This relies upon the formation of granulation tissue, wound contraction and epithelisation (Demetriou & Stein, 2011). This impacts the remodelling phase particularly in large wounds resulting in

the restoration of the tissue only being achieved to a limited amount (Anderson, 2003).

Wound complications

Wound healing complications can have a variety of catalysts which can include poor nutrition, contamination, repeated trauma and infection (Demetriou & Stein, 2011). Glucose and protein are vital for progression of wound healing, so a good balanced diet is essential. Infection, necrosis, foreign material and continued tissue damage will all cause inflammation and prevent granulation (Anderson, 2003). Poor vascularity in the wound bed also leads to delayed granulation. A chronic granulation bed, characterised by tough fibrous yellow/white tissue, will delay epithelisation, as will continued trauma or infection (Demetriou & Stein, 2011).

In slow-healing chronic wounds the continued exposure of devitalised tissue increases the risk of colonisation by microorganisms. Tissue necrosis caused by hypoxia due to poor blood perfusion to a wound is also likely to create the ideal growth conditions for anaerobic wound microflora (Bowler, Duerden, & Armstrong, 2001).

Many of the wounds treated were either in a static stage of healing with chronic granulation tissue present or chronically infected.

Treatment

Dressings

The benefits of dressings include:

- Providing support to the wound and surrounding tissues.
- Providing protection from contaminates and subsequent infection.
- Facilitating coaptation of wound edges (Bosco, 2012).

A dressing can help maintain an appropriate moist healing environment; it should be non-adherent, non-restrictive and sterile (Caldwell, 2014). Selection of the correct dressing is important as this can also promote the desired wound healing; for example, chronic granulation tissue will require a dressing that actively debrides and restimulates the formation of healthy granulation tissue (Caldwell, 2014).

Different dressings will be required at different stages of wound healing (O'Dwyer & Demetriou, 2016) in any species or type of wound. The pangolin's wounds were monitored closely and regularly reassessed and the dressing adapted to the wound requirements. The remoteness of the centre and the limited availability of wound care products in Vietnam has resulted in some more unusual yet seemingly successful dressing choices, with sanitary towels and tampons commonly used as an absorbent layer within a dressing.

The different types of dressing material and topical products used while treating the pangolins alongside their purpose are included in Table 1.

The dressing layers commonly used in the pangolins consisted of:

- Primary layer in direct contact with wound (or topical wound treatment, e.g. silver sulfadiazine cream).
- Secondary layer of absorbent material or protective padding.
- Tertiary cohesive supporting layer to hold the dressing in place.
- Final layer of elastic adhesive bandage to attach the dressing to the pangolin's scales.

The tertiary layer when applying a dressing to a pangolin's tail had to be applied much tighter than would normally be expected. With the armour of rigid keratin scales providing protection to the skin underlying them, there was minimal risk of vascular compromise from a dressing applied too tightly. The final adhesive layer was required to attach the dressing to the scales to prevent it slipping off while also providing an additional protective layer.

Topical products

In the chronic, non-healing wound, topical products can be considered as an adjunct. At the centre, honey and silver were the two products most commonly used. Honey has historically been used in wound management and is widely used with exotic species. Medical-grade Manuka honey is recommended with distinct actions having been identified, including antimicrobial properties, anti-inflammatory, debridement and exudate control (Mickelson, Mans, & Colopy, 2016; White, 2016). Silver is also a widely used antimicrobial agent, with the most common topical silver formulation, silver sulfadiazine cream (SSD), readily available in Vietnam. It has been shown to penetrate necrotic tissue and enhance wound epithelisation (Mickelson et al., 2016).

Light therapy treatment

Light therapy treatment is a minimally invasive treatment technique. It works by restoring energy to the damaged cells in the form of wavelengths of light. Specific wavelengths of light are aimed at specific cells. It also increases blood supply, reverses the cell death process and ensures cell repair, increases immune system activity and has a systemic effect and reduced excitability effect of nervous tissue, thereby relieving pain (Dantre Health Products, 2018a).

A Photizo Vetcare was the ideal "field" wound care product and was used in wound management. A small, hand-held, battery-powered unit, delivering 633 nm (red) and 850 nm (infrared) wavelengths of light simultaneously at 6 J/cm^2, over an area of 4.7 cm^2, with each treatment cycle pre-programmed to provide an effective one-time dose over that area (Dantre Health Products, 2018b).

Light therapy treatment was incorporated in to the wound management protocols with an initial consecutive 3-day treatment cycle followed by every other day treatment for the second week. This provided a balance of cumulative treatment benefits and the number of veterinary interventions

Table 1. Types of dressing and topical products used at the centre.

Type of dressing/topical product	Purpose	Example of product used
Adherent	Debridement of tissue	"Wet to dry" saline-soaked swab
Non-adherent	Protection without adhering to the wound surface	Zorbopad™
Absorbent	Absorb exudate in large wounds, or those producing excessive exudate	Advasorb® sanitary towels/tampons
Antimicrobial – silver	Broad-spectrum antimicrobial	Silver sulfadiazine cream
Antimicrobial – Manuka honey	Broad-spectrum antimicrobial effect, wound debriding, anti-inflammatory, maintaining a moist prime healing environment	Activon® Tube medical honey Algivon® Plus
Cohesive	Supportive material and to hold dressing in place	Wrapz™
Elastic adhesive	To attach the dressing securely to the scales	E-band

each individual had. The treatment was carried out in the animals enclosure where possible to reduce stress and with minimal restraint it was well tolerated in most individuals. It was combined with dressing changes and wound flushing, topical and systemic treatment (Figure 2).

Case studies

Two case studies are included below; the history has been taken from clinical notes prior to the author's visit to the centre and the treatment and images are that which was undertaken during the visit.

Case study 1: adult female, 4.9 kg, BCS 2/5

History

Presented with scales sloughing off tail, subsequently requiring a partial tail amputation: 15 cm of tail were removed distally to leave healthy tissue and muscle. With ongoing complications; purulent discharge, malodour and infection, a further three surgical debrides were required to remove sloughing and necrotic tissue and a piece of exposed discoloured bone.

Wet to dry debriding dressings and active charcoal dressings were used as part of the wound management.

Treatment

Wound assessment, dressing changes and light therapy treatments were all carried out simultaneously to reduce the disturbance to the pangolin. The location of the remaining surrounding scales made treatment difficult as there was limited access to the tissue, with pockets forming underneath the remaining scales on the lateral edges of the wound.

The wound was thoroughly flushed, cleaned and assessed prior to the light therapy treatment.

Light therapy treatments were carried out on three consecutive days, then every other day for a following 6 days, totalling six sessions, each lasting 2 minutes.

A reinforced alginate dressing impregnated with 100% Manuka honey (Activon®) was applied post final debridement, and subsequent dressings included Activon® Tube medical honey applied to the wound surface prior to a non-adherent dressing.

Figure 2. Light therapy treatment.

Figure 3 shows the wound healing over a 12-day period (from left to right). The granulation tissue appeared to revitalise, changing from a dull grey colour to red. However, there was still some evidence of focal necrotic tissue, requiring further treatment and continuation of dressings.

Case study 2: adult male, 7.2 kg, BCS 2.5/5

History

Presented on arrival at the centre with a tail tip wound, this was managed medically with topical treatment and dressings and the wound appeared to be healing, reducing in size with contraction of the wound edges. Unfortunately, despite careful management the wound became infected and he later presented with scales sloughing off higher up the tail. Approximately 25 cm of the distal tail was implicated and required amputation. Several further surgical interventions were also required to debride exposed necrotic tissue or bone.

Treatment

This was the largest of the tail wounds undergoing treatment, approximately 10 cm × 6 cm. The wound appeared dull and grey, with yellow-coloured bone exposed centrally. Figure 4 shows the wound healing over a 12-day period (from left to right).

Three initial light therapy treatments were carried out on consecutive days, followed by a further three sessions over 6 days, totalling six sessions. Due to the size of the wound, treatment sessions lasted 4 minutes to allow enough exposure across the whole wound.

A further surgical debride was required after the second light treatment session as there was a large amount of inactive granulation tissue, with a deep pocket of necrotic tissue and slough bilaterally, all of which increased the risk of wound infection.

Conclusion

Wound care in any exotic species can be a complex undertaking. This article highlights the veterinary nursing challenges faced when treating wounds in an unfamiliar species, with a focus centred around a holistic nursing approach.

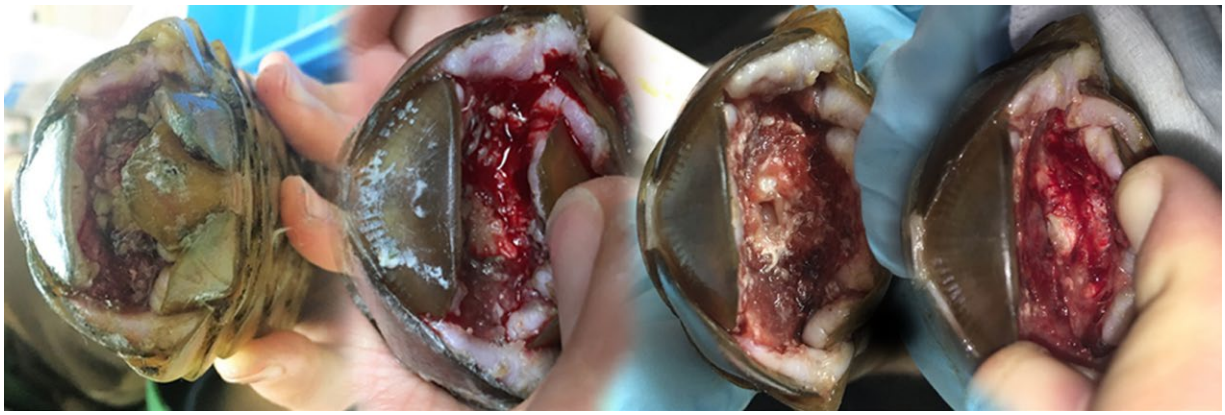

Figure 3. Case study 1.

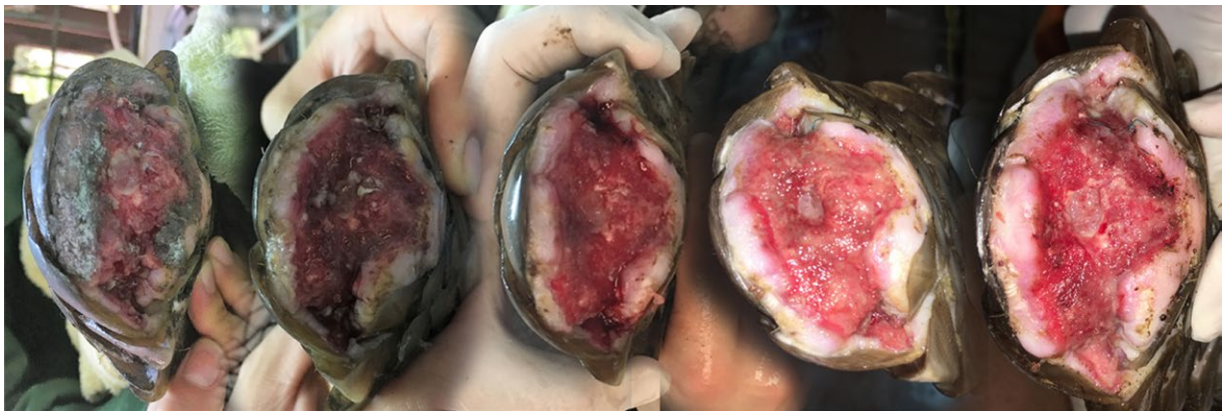

Figure 4. Case study 2.

The limited supply and availability of veterinary wound care products resulted in some innovative ideas with varied success. However, by applying basic principles of wound healing, alongside trialing a new therapeutic technique using light therapy, positive outcomes were achieved. Wound contraction was evident as well as regeneration of devitalised tissue.

The Photizo machine was donated to the centre and continues to be used as part of wound care management. Topical products and dressing materials used are also continually changing based on evidence of successful outcomes and availability.

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